

Sun City Water Company & Sun  
City West Utilities Co for  
Approval of CAP Water

ORIGINAL



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9826 Pinecrest Drive  
Sun City, AZ 85351  
March 28, 2001

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Commissioner William Mundell  
Arizona Corporation Commission  
1200 W Washington Street  
Pheonix, Arizona

AZ CORP COMMISSION  
DOCUMENT CONTROL

Gentlemen:

It's no secret the CAP water project proposed by Citizens Utilities would place a \$15,00,000 (+/-) construction burden on the people of Sun City. But there is an attractive alternative to that complex system and it involves no capital costs to Sun City: The Agua Fria Recharge Project. According to information received, CAWCD will open bids in March, begin constrution in May, and water flows in October.

I was a member of the Cap Water Task Force (one of the two from the Home Owners Assn.).

A short time ago I obtained a copy of a CAP WATER booklet published by Home Owners Assn.(HOA). Said booklet appears to be a compendium of the things HOA has been saying on the subject. I soon realized that here was an opportunity to give you an item-by-item critique of the various HOA claims on the CAP issue.

The critique is held by fasteners in the center. Pages from (plus its fancy cover) from the HOA booklet are in the pocket on the left. Informational material is in the pocket on the right.

If you or the staff have any questions, please call me at 623 933 1162.

Very truly yours,

*Donald J. Coleman*  
Donald J. Coleman

Arizona Corporation Commission

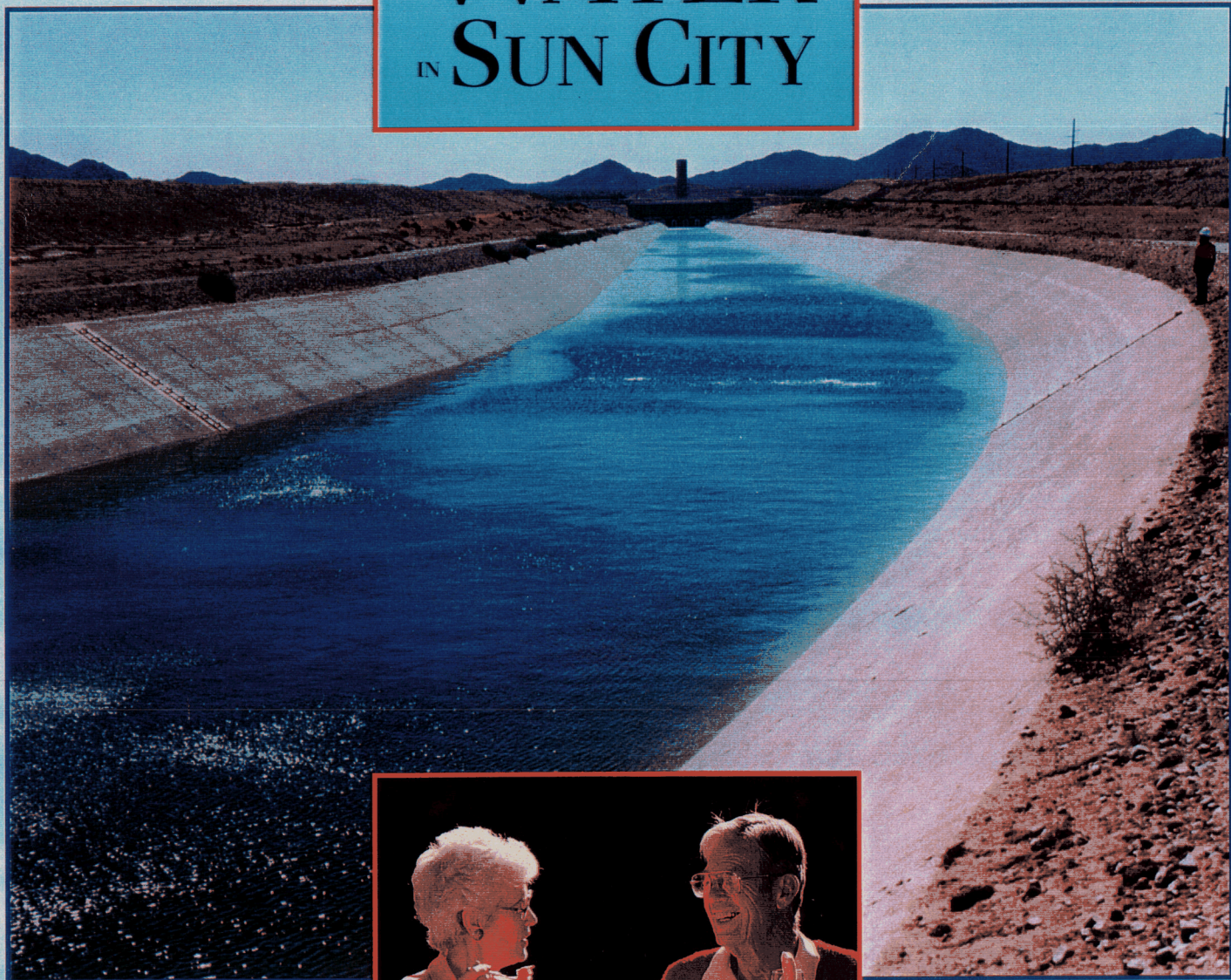
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# CAP WATER IN SUN CITY



***Sun City's Advocate Since 1963***

SUN CITY HOME OWNERS ASSOCIATION

*This printed information was funded by a grant from the Arizona Department of Water Resources Conservation Assistance Fund*

## WHY ARE SUN CITY RESIDENTS CONCERNED ABOUT THEIR WATER?

For most residents of Sun City, the water we use in our homes is something we take for granted. In part, this casual attitude toward our water supply comes from our experience in living in communities in other states where the supply of good water is simply not an issue. An abundance of either rainfall or groundwater has been the rule in most parts of the United States, and cities and towns generally have had no problem in providing an adequate supply of water to their communities.

But we live in a desert.

Our average rainfall in the Valley doesn't come anywhere near matching the needs of our growing communities. Historically, there were two major sources of water for use in the Valley. The first is the Salt River Project (SRP), which supplies water from the Salt and Verde rivers to the area within the legal boundaries of the SRP. None of that water is available to Sun City.

The second major source of water for residential use is pumped groundwater. This is water drawn from the underground aquifer, which exists, at varying levels, beneath the Valley. That aquifer is, in part, replenished each year by natural recharge from rainfall and the streams from outlying areas that feed into the Valley.

But the major problem with the use of groundwater is that our population is increasing far faster than natural recharge can replenish it.

The result is what is called "overdrafting." The population of the Valley is using groundwater far faster than nature can restore it, and the result is a falling groundwater table.

The problem is particularly acute in the Northwest Valley, which includes the Sun City area. The water table in our area of the Valley has dropped hundreds of feet since records were first kept of groundwater levels, and it continues to drop. The reason for that drop is not hard to find. The rapid growth of homes in neighboring Glendale, Peoria, Surprise and Sun City West have all increased in population to levels that were undreamed of when Sun City was first created. These new residents get their water supplies from the same underground aquifer as Sun City does, so overdraft was inevitable.

The impacts of overdrafting and a dropping of groundwater table are threefold: (1) increased cost of pumping; (2) deterioration of water quality; and (3) land subsidence.

The deeper the wells from which you are pumping groundwater, the greater the cost in power and other operating costs. And that cost has to be borne by the residents of Sun City. And the deeper you go to draw up groundwater, the more the quality of the water becomes a problem. The deeper you go, the more heavily the water is mineralized, so it becomes much "harder." It has a bad taste and you experience an increase in the clogging of the pipes that make up the water distribution system.

But land subsidence is the most obvious impact of a falling groundwater table. Just to the south of Sun City, particularly in the area of Luke Air Force Base, one can see remarkable visual evidence of the fact that the level of the land has been dropping steadily. The extraordinary levels of land subsidence, which are clearly visible, are only part of the story, however. The most important evidence available to us is that the Luke area of land subsidence is slowly spreading. And the direction of that spread is moving inexorably closer to Sun City.

The only thing that will stop the spread of land subsidence in the direction of Sun City is to substantially reduce pumping groundwater from beneath our community.

How to go about solving the water problem facing Sun City is not a simple problem. In fact, it is one of the most complex and difficult problems any community can face. But one thing is indisputable -- water is a problem that cannot be ignored.

Residents of the Sun Cities and Youngtown with professional background in water resource management formed the "CAP Task Force" and studied the facts regarding water in the Northwest Valley, and their conclusions are an important part of these papers.

The papers in this booklet are provided by your Sun City Homeowners Association in an effort to educate the community about the water situation, and the measures, which will be essential to deal with it.

## **SUBSIDENCE: THE MOST OBVIOUS PROBLEM**

Subsidence in the surface of the land is the inevitable result of the overdrafting of the groundwater aquifer. As water is pumped out of the ground in amounts substantially in excess of natural replenishment, then over time the land above the groundwater table slowly subsides and land fissures develop.

The amount of land subsidence that will occur in a given area will depend upon the water table, the groundwater pumping rates, the types of soils and the rates of natural recharge. How all those factors will interact to create subsidence in a given area is very difficult to predict, and hence the best predictor of future subsidence is past experience in the particular area of concern. That is, when you have a situation of known groundwater overdrafting (such as we now have in the Northwest Valley), the best guide to use in predicting future subsidence is to look at the history of what is happening in that area.

The attached map shows the area of subsidence that has been occurring in the area just to the south of Sun City. This area is generally known as the "Luke cone of depression," since it is centered in an area adjacent to Luke Air Force Base. The historical records show that this area of subsidence is gradually spreading northward, and that the rate of spread is increasing. The Sun City Homeowners Association (HOA) obtained a photographic record of that subsidence and has posted those photos in its main office on Coggins Drive. Those photographs show a clear and indisputable record of land subsidence that is remarkable in its effect on the land surface immediately to the south of our community. Those pictures are worth examining for the view they give of upended and broken pavement and underground piping. And those views, of course, are a predictor of the damage that could occur in the Sun City community.

HOA has also commissioned two studies by an eminent geology expert (Herb Schumann) to show the scientific basis of the spread of subsidence now heading in the direction of Sun City. Dr. Schumann's studies clearly show the future danger of subsidence in the Sun Cities area.

In the Northwest Valley, the spread of subsidence also correlates with three other particularly nasty features. First, the underground complex surrounding Luke has an extremely high salt content. As water is withdrawn from beneath Sun City, and the underground water table drops, there is an increasing opportunity for very salty (i.e., highly mineralized) underground water to migrate northward toward Sun City. The potential result is an even greater amount of degradation in the quality of the water, which is used by Sun City for all its residential drinking water.

The second extremely serious impact of subsidence is that once it occurs, it is irreversible. As the surface of the land subsides, the sub-surface layers of land compact as water in the soils is squeezed out. And once the water that is normally a part of underground soils is removed, the sinking of the land compacts those soils in a manner, which precludes water from reentering. As a result, once subsidence occurs, the land becomes permanently sunken, and there is no way to correct the situation.

And third, the rate at which the Northwest Valley is overdrafting groundwater is steadily increasing. That is, as communities are being built up around Sun City, their increasing population places an increasing demand on the groundwater supplies. Neighboring communities recognize this problem, and are taking steps to make better use of CAP water themselves. However, their efforts, while laudable, are currently not enough to stop the steady drop in the water table. Thus, a combination of overdrafting by the Sun Cities, coupled with overdrafting by its surrounding communities, has led to a major problem.

Obviously, the time to deal with subsidence is before it occurs. And the only way to do that is to stop the overdrafting of the underground aquifer. Any reduction in groundwater pumping will help the situation. The use of CAP water by the residents of Sun City is probably not enough to completely resolve the threat of subsidence in our community. But it is an important step in the right direction.

## CAP WATER: WHAT IS IT?

"CAP" is the "Central Arizona Project." CAP is the broad acronym used to designate the canal system that is used to bring water from the Colorado River across Arizona to Phoenix and Tucson.

Going back four decades ago, the political leadership of Arizona recognized that in order for the major metropolitan centers of Arizona to be able to grow, we were going to have to find an additional source of water. The water available here in the desert was a very finite and limited quantity, and would be nowhere near enough to accommodate the growth that was clearly on its way. Not only was surface water limited and subject to drought cycles, but groundwater supplies were even less likely to be adequate for the long run.

Arizona fought a long and difficult legal battle with the states of Colorado, California and Nevada to get a fair share of the water available in the Colorado River. The result of that legal battle was a compact between those three states (and the U.S. Government) which guaranteed Arizona enough water to assure its economic future. But there was no way to take delivery of that water. That is, no natural channel exists which would get water from the Colorado River over into the Phoenix Valley.

Accordingly, the state of Arizona entered into an arrangement with the federal government to build the CAP canal system, which would deliver Arizona's share of Colorado River water to the Valley. That CAP canal is a marvel of modern engineering, and is now fully operational.

Colorado River water is basically good surface water. It is used by communities all up and down the Colorado basin, and is a mainstay of the water system, which serves Southern California. It can be used directly on agricultural crops, although it is often mixed with local water supplies to deal with its slightly higher mineral content. It is suitable for use on golf courses as turf irrigation, although most golf course users will do a minimal filtration in order to avoid clogging sprinklers.

Colorado River water is also used extensively for drinking water purposes, although treatment is required. Both Phoenix and Glendale, to cite two close-by examples, treat CAP water for use as part of their municipal water supply.

As you would expect, CAP water is not cheap. The future costs of CAP water are expected to continue to rise, and costs which could be as much as four times the present cost of pumped groundwater are possible. But unfortunately, it's the only alternative we have.

Firm subscription or contract speaks for almost all the currently available CAP water. As a result, you just cannot go out in the market and buy CAP water. However, Citizens Water Resources did, at the very inception of the CAP program, reserve a block of CAP water for use by Sun City. That amount of water (4,189 acre/feet) is a relatively small portion of Sun City's overall residential needs, but is a significant offset to the groundwater pumping now being done in the local area.

Unfortunately, that Sun City block of CAP water is now in a "use it or lose it" situation. If that CAP water is not put to productive use in the Sun City area, Citizens will not be in a position to charge for it, and hence will return it to the general state pool of CAP reserves. And once lost, it is gone forever to our community.

HOA leadership studied the possibility of getting other surface water supplies to enable it to deal with the subsidence problem (purchasing water from Indian tribes, for example), but no other possible water source could be made to work.

## HOW CAN CAP WATER BEST BE PUT TO USE IN SUN CITY?

In its deliberations on the use of CAP water, the CAP Task Force considered at least seven different plans for using CAP water in the Sun City community. Each of those plans had some merit and some disadvantages. Each of the plans was analyzed to bring out all the facts of what was involved in making use of CAP water. That research work very quickly revealed that the Task Force, in trying to decide what was the best way to make use of CAP water, would first have to agree on the objectives for putting CAP water to use, and then measure the various plans against those objectives.

In other words, an understanding of the goals, which the community had in making use of CAP water, had to be the driving force in deciding the best plan to make use of CAP water.

It didn't take long to recognize that one basic goal was of paramount importance to the Sun City community. Namely, if Sun City residents were going to pay for the CAP water, then it had to be put to use directly in Sun City. To deal with problems such as subsidence, Sun City needed the benefit of real water which could be put to use in restoring the effects of the over-pumping which impacted groundwater levels. There was no value, for example, to implementing groundwater recharge projects located some distance from Sun City. In addition, whatever plan was chosen had to be feasible from an engineering perspective, and had to be doable at a cost that could be borne by the water rate payers of Sun City. It was also felt that any water use plan, which didn't meet that one basic goal of being of direct use in our community, would not be acceptable to the people who would have to pay for CAP water.

For example, several persons thought initially that storing water in a recharge basin a considerable distance north of Sun City might be acceptable since, with time, that water would seep down underground and then likely migrate southward underground and ultimately benefit the water levels under Sun City. However, it was soon realized that underground migration rates took place, at best, in terms of feet per year. And as a result, water recharged miles north of Sun City would take many decades to even begin to affect our community. Because such a plan would not directly benefit the people who would be paying for the CAP water, it was judged unacceptable.

Unfortunately, there are no land areas available in Sun City, which could be put to use as a settling pond for recharge purposes.

What was realized early on in analyzing the possible uses of CAP water is that if you shut off the pumps that are presently pumping groundwater beneath Sun City, you bring about an immediate and direct relief to the pressure being put on the underground aquifer. That is, the best way to stop the effects of mining groundwater is to cut back on

existing pumping. And so the CAP Task Force looked for ways to use CAP water in a manner that would reduce the current level of pumping.

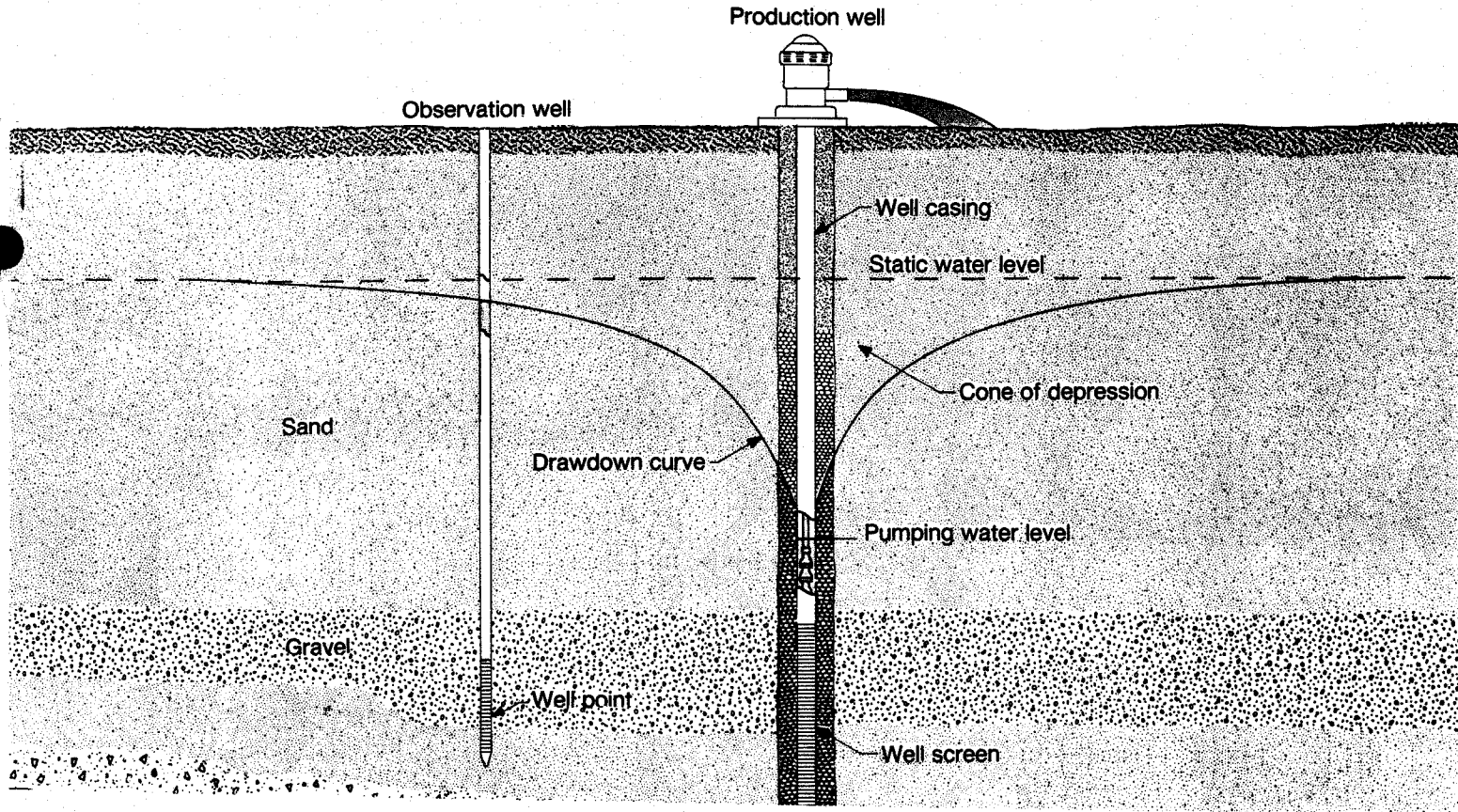
One possibility, of course, would be to build a CAP water treatment plant and use the water for drinking purposes as a replacement for the water currently being pumped for residential use. That idea was rejected because the costs of such treatment would have been prohibitive in light of the amount of water available. A second possibility was based on recognition that the Rec Centers' golf courses in Sun City currently have the right to pump groundwater for turf irrigation purposes. Since CAP water has been used for years for golf course watering with no ill effects, this made it an ideal solution to be considered.

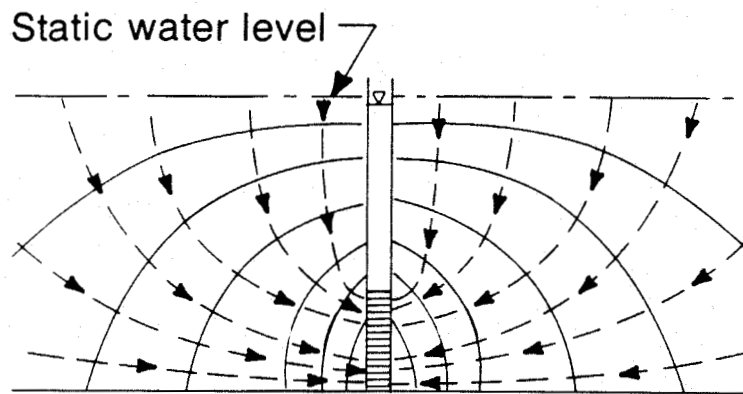
After a great deal of study, a plan was evolved to bring CAP water from the CAP canal to the Sun City golf courses, and thus save groundwater pumping which would otherwise have been required to keep the courses green. This plan requires the construction of a pipeline to get the CAP water from the canal to Sun City, and some filtering of the water to remove solid materials that might otherwise clog the delivery system. Engineering studies were done to make sure the plan was feasible, and to carefully estimate the costs involved. Citizens hired independent engineers to make those studies, and then the Sun City Home Owner's Association, through its grant, hired its own engineer to verify that the costs were within the limits that had been estimated.

The more it was considered, the "golf course" plan only made common sense. If you stop pumping groundwater, you give the aquifer a chance to recover. The engineers on the CAP Task Force were quick to point out that the simplest plan is usually best, and the simple approach of using CAP water on the golf courses to reduce the present over-pumping represents the kind of common sense that the residents of Sun City would readily understand.

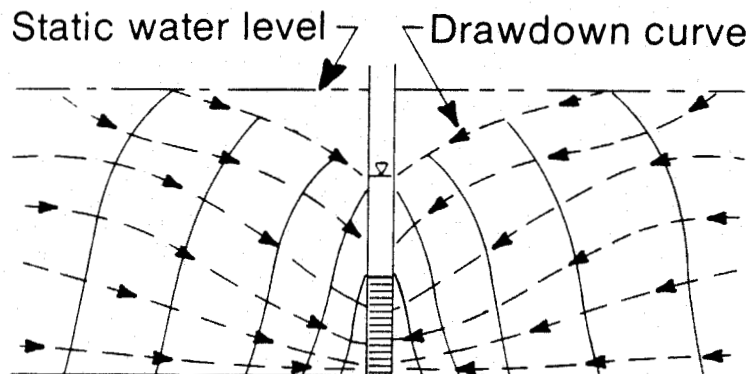
It was recognized that the "golf course" plan was more expensive than plans, which would recharge the water at some distance from Sun City. However, as the various possible alternative plans are considered, it becomes obvious that only the golf course plan meets the basic goal which was set to evaluate how to best make use of CAP water. And as a result, the CAP Task Force clearly and firmly recommended going forward with a plan to use CAP water to substitute for most of the current groundwater pumping on the golf courses.

This paper is only a very brief summary of all the analysis that went into the choice of the "golf course" plan as the best vehicle to put CAP water to use in Sun City. The serious student of water use planning should review the CAP Task Force report for further information on the subject.

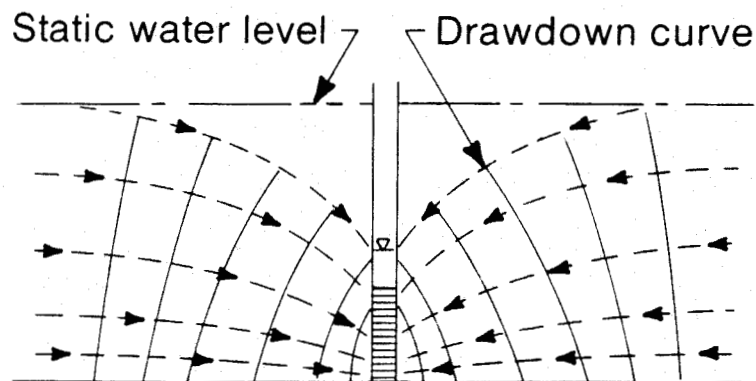




**A. Initial stage in pumping an unconfined aquifer. At the instant the pump is turned on, water begins to flow toward the well screen.**

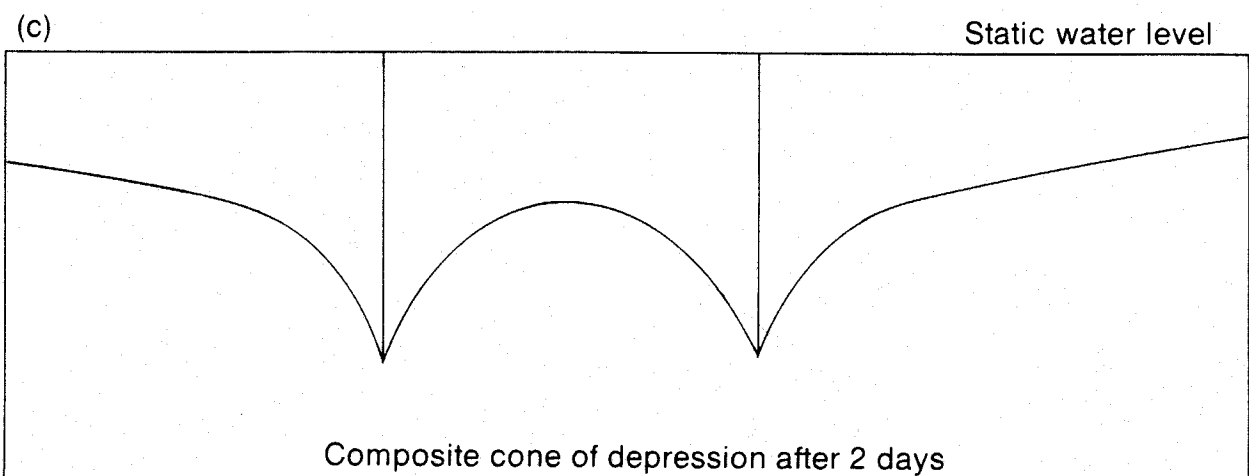
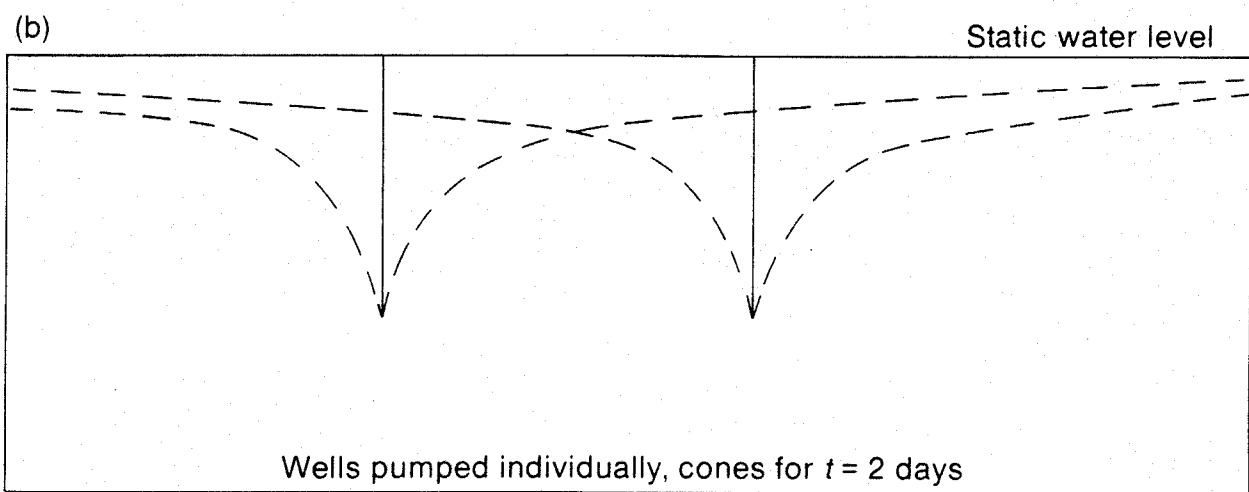
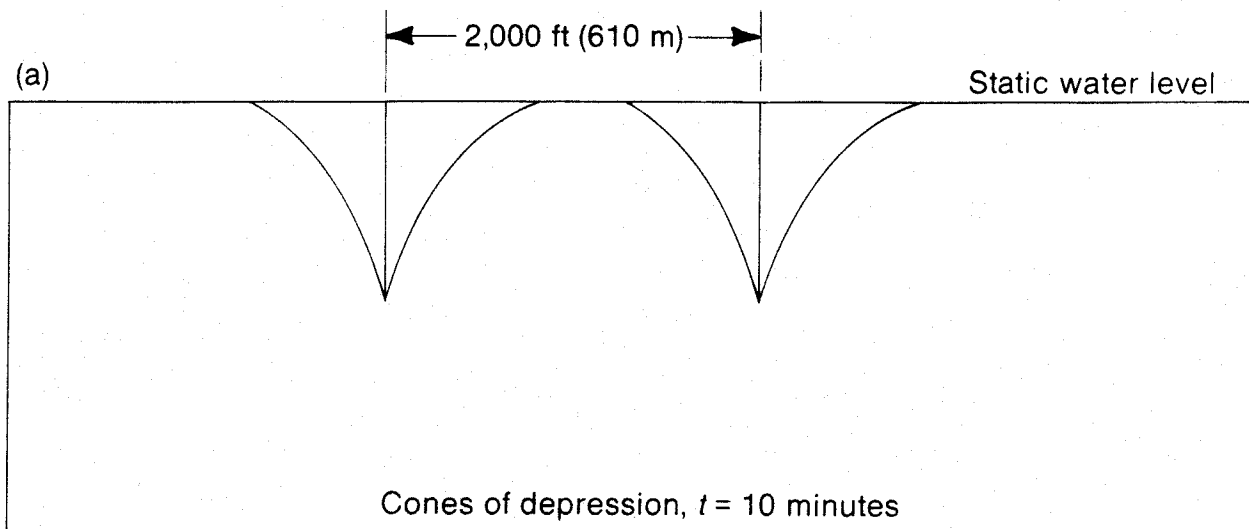


**B. Intermediate stage in pumping an unconfined aquifer. Although dewatering of the aquifer materials near the well bore continues, the radial component of flow becomes more pronounced.**



**C. Approximate steady state stage in pumping an unconfined aquifer. Profile of cone of depression is established. Nearly all water originates near the outer edge of the area of influence, and a stable, mainly radial flow pattern is established.**

**Figure 9.6. Development of flow distribution about a discharging well in an unconfined aquifer that is 33% screened. (*Water and Power Resources Service, 1981*)**



Assumed conditions

$T = 50,000$  gpd/ft ( $621 \text{ m}^2/\text{day}$ )

$S = 5 \times 10^{-4}$

$d = 12$  in (305 mm)

$Q = 500$  gpm ( $2,730 \text{ m}^3/\text{day}$ )

**Figure 9.29. Interference between adjacent wells tapping the same confined aquifer. Composite cone is for both wells pumping simultaneously under the assumed conditions.**

## A CRITIQUE OF "CAP WATER IN SUN CITY"

Re PAGE 1, Seventh statement, beginning with:  
"The problem is...."

This is definitely not true. According to publications of the DEPARTMENT OF WATER RESOURCES (DWR), agricultural irrigation continues to be the major cause of our dropping groundwater level. Only one-third of the groundwater pumping in the Phoenix AMA is due to Municipal and Industrial use. Two-thirds of the pumping is for agricultural use. According to DWR, that ratio can be expected to change somewhat by years 2015 and 2040, but agriculture would continue to dominate.

Can it be that the HOME OWNERS ASSOCIATION (HOA) WATER COMMITTEE has not read the "ARIZONA WATER RESOURCES ASSESSMENT" prepared by ARIZONA DEPARTMENT OF WATER RESOURCES and released in 1994? The words are there for anyone to read. Did HOA deliberately ignore this information in order to make the situation seem more desperate and thus gain support for the golf course project?

PAGE 2, first statement. Beginning with..."The deeper...

Regarding an increased energy cost for pumping groundwater, the water theoretically "saved" annually under the "golf course" scheme would average about five and one-half inches under Sun City. Assuming the power required for well pumping is proportional to the depth-to-water, (deemed 400 feet for this example) then that five and one-half inches could theoretically reduce the pump power demand about 0.115% per pump. The statement, while not untrue, is certainly misleading.

Re PAGE 2, second and third statements. Beginning with:  
"But land subsidence ...."

This statement makes exciting headlines but is lacking in substance. "Subsidence" is the most common refrain heard whenever someone from HOME OWNERS ASSOCIATION (HOA) is quoted on the subject of groundwater. But to my knowledge, they have not promulgated their calculations.

According to information from the DEPARTMENT OF WATER RESOURCES (DWR), over the last six years the annual rate of water table decline under Sun City has been about 40 inches per year. If every drop of Sun City's CAP allocation were to accumulate under Sun City (which it obviously will not), it would represent about 14% of the current annual decline in our water table.

Is this 14% large enough to be deemed "substantial"? Hardly! Especially if the Sun City residents are forced to pay about \$15,000,000 for the golf course watering scheme that is claimed to produce 14% benefit..

About three years ago DWR was planning to monitor subsidence by means of a global positioning system. Rather than imitating "Chicken Little", HOA should first report the results of DWR's research.

Reduced golf course pumping will not result in a layer of groundwater reserved for Sun City alone. That groundwater will flow toward the well pumps outside of our boundaries if their demands are greater than ours. Remember, on this planet, water seeks its own level (even in Sun City).

But a more easily visualized impact which outside wells have upon Sun City groundwater occurs when we consider the phenomenon called the "CONE OF DEPRESSION" (sketch attached). Please notice this quote from the book "Groundwater and Wells" (considered a classic in its field): "When pumped, all wells are surrounded by a cone of depression. Each cone differs in size and shape depending on the pumping rate, pumping duration, aquifer characteristics, slope of the water table, and recharge within the cone of depression of the well." F.G. Driscoll, Ph.D, 1986.

Next, one must realize the CONE OF DEPRESSION created by wells of Peoria and Surprise could legally extend more than one mile underneath Sun City under the terms of the well PERMIT process of Arizona. The only restraint is that the cone of depression of the outside wells must be less than 10 feet deep over any Sun City well (unless the owner of the affected well provides a waiver).

Here's an example: A copy of the PERMIT for Peoria well 55-538774 reveals it's CONE OF DEPRESSION could reduce the water table over Sun City well #55-606519 by 10 feet or more, but for some reason a waiver was granted. Said PERMIT further reveals that this same well # 55-538774 could reduce the water table above Sun City well # 55-603236 by 9.9 feet (but no waiver was required here because the impact would be less than 10 feet).

Because the cone of depression of any well extends to the top of the water table, the above-mentioned and possibly other outside well pumps may be busily reaching out and scooping up water from the very place the Task Force says it will be accumulating the CAP water: The top area of our water table!

There is nothing HOA can do about this. And thus it is foolish to believe any significant amount of water will accumulate under Sun City as a result of shutting down some Sun City golf course pumps! See attached list of wells in Peoria which, based on their size and location, could be scooping up water from underneath Sun City right now.

Re PAGE 3, First statement. Beginning with...."Subsidence in the...":

When the water table drops, its buoyancy effect (it's called "Archimedes' Principle") on the underground regolith is reduced in some proportion to that drop. Then the intergranular pressure on the deeper regolith increases in some proportion to the value of that lost buoyancy. Subsidence occurs when the regolith compacts because the new pressure has exceeded the modulus of elasticity of some of the underground material. Again I say, HOA is trying to scare people without presenting any evidence for its conclusions. They will have to publish calculations which substantiate these claims before they can be believed.

Re PAGE 3, second statement. Beginning with.."The amount..."

HOA's terminology is incorrect. "Soil" is a combination of mineral matter, air, water, and organic matter. The material HOA is trying to describe is properly called regolith (a layer of rock and mineral fragments produced by weathering).

Re PAGE 3, third statement. Beginning with..."The attached..."

The key to actually understanding this problem is to become acquainted with the geology under Sun City and to do the necessary calculations to determine intergranular pressures underground. Instead HOA directs us to look at a map and then repeats the old subsidence theme they have delivered for years. Has HOA checked with Peoria, El Mirage, to Surprise see if their timeline for subsidence agrees with HOA's? By the way, just what is HOA's timeline for this impending disaster?

Re PAGE 3, fourth statement. Beginning with... "HOA has ..."

HOA will have to make these studies available to the general public. Otherwise we'll have to consider the statement to be just another empty threat. To repeat, a drop in the groundwater level usually results in an increase in the intergranular pressure down below because of the corresponding reduction of the total buoyancy effect of the groundwater (good old Archimedes again). If that underground pressure is great enough, some compaction will occur. I haven't heard HOA say why it occurs. Only: "It's coming"!

Re PAGE 3, fifth statement. Beginning with..."

This paragraph is misleading. First, water does not flow up hill (except under certain artesian conditions and there is no evidence of such conditions around here). Reports prepared by experts at the Department of Water Resources (DWR) reveal the elevation of Sun City groundwater is significantly higher than that of Luke Air Force Base. Second, one has to consider the incredible rate of housing development in the El Mirage and Surprise communities. Their wells will be pulling the salty water toward them before the saline migrates towards Sun City. And existing reports reveal the Surprise/El Mirage water table is lower than Sun City's. With all this in mind, why does HOA think the salty water is headed toward Sun City? This appears to be just another scare tactic by HOA in order to obtain support for their flawed golf course scheme.

Re PAGE 4, 1st statement, second sentence:

HOA has the sequence backwards. When the modulus of elasticity of the deeper aluvium is exceeded due to the weight of the material above, some aluvium will compact. The usual consequence of compaction is subsidence. According to some sources, subsurface "bridging" could reduce that potential subsidence.

Re PAGE 4, Second statement. Beginning with... "And third..."

It sounds like HOA is belittling our neighbors efforts towards recharging. It appears HOA has forgotten that about three years ago, the Northwest Valley Advisory Board condoned the idea of giving the Agua Fria Division of Citizens Utilities more than half the Sun City CAP allotment! Sun City HOA and Sun City West PORA were and still are members of the Advisory Board. (For the record, I believed it was a prudent decision.) At that time it was thought Citizens Utilities would make quick use of the allocation while Sun City would continue wrangling over the use of CAP water. Then at least some of the CAP water would then be put to use promptly.

Re PAGE 4, Third statement. Beginning with..."Obviously..."

HOA has been talking about a subsidence threat for several years. It's beginning to sound like an empty threat. To my knowledge, HOA has not revealed its calculations and predictions. The time to put up or shut up is overdue. (Incidentally, I myself am working on some calculations that should provide a reasoned prediction of the subsidence threat to Sun City. It's not all that mysterious, but it does take some time.) Here's a hint:

Go to the Department of Water Resources and look at the Drillers Reports of hundreds of wells pertaining to ones area of interest. Those logs describe the materials brought up by the drill bit as it bores its way into the earth and thus reveals what material down below and also its depth. Pay DWR 50 cents each for a Xerox copy of the Reports that look interesting. When you get home, and starting at ground level and incorporating the present water table depth, calculate the unit pressures on the regolith as you work your way down the various layers of aluvium for 1000 or perhaps 1500 feet. Next do it all over again but drop the water table 200 feet (remember, you will have higher intergranular pressures because you will have lost 100 feet of bouyancy). Each time you make a run, you will have to compare the calculated unit pressures to the elastic limit of the of the various materials encountered. And when you get down to a water level where the elastic limit is being exceeded it's time to check the rate of groundwater decline to see where you stand. It's crude and cumbersome but it will give one a better basis for a prediction of subsidence than merely pointing to a map and proclaiming "the sky is falling!"

Please note that, in order to do the calculations properly, one has to know the unit weight and the modulus of elasticity of the aluvium below!

The most "obvious" thing about HOA's golf course scheme is that they believe in the fiction that unpumped groundwater under Sun City will remain there even if the water level of our neighbors recedes. Unfortunately for HOA, on this planet, water seeks it's own level.

RE PAGE 6, third statement. Beginning with..."HOA..."

If HOA has any documentation that supports such dialogue with the Indian tribes, this would be a good time to reveal it. I haven't noticed this in their press releases.

Re PAGE 7, first six statements.

All of this dialogue reveals there was a flaw in the entire CAP proceedings. And in my opinion, IT WAS A FATAL FLAW!

Only a small number of the Task Force people appeared to have any understanding at all of the geology of the Range and Basin area of Maricopa County. Even fewer had a realistic concept of the groundwater within such an area. And because so many members were naive about the subject of groundwater, it was possible for a few strong-minded individuals to promote the false concept that unpumped groundwater would accumulate under Sun City.

I did not attend Meeting #1 of the Task Force. But records pertaining that first meeting reveal it was devoted to developing a mission statement, establishing ground rules, the work schedule, a list of 26 Issues and Concerns, etc. The record also reveals that, at this early stage, someone wanted to know if CAP water would be used on golf courses. Think about it! Without any finding of fact at all, one or more members were already thinking about spraying golf course grass with CAP water!

The record of Meeting #1 does not reveal if any members had any interest in receiving a general briefing on the subjects of geology and groundwater. That's unfortunate, because with a decent set of slides, the fundamentals could easily have been imparted in two hours or less. And because so many did not understand the basic concepts of our local ground water, the fiction that it was necessary to pipe CAP water directly to Sun City to gain any benefit was voiced time and again by certain members. And this idea probably began to sound plausible to those who brought no background in these subjects with them. And if those people evidently did not read the reference books that would have enlightened them.

With such a technically naive audience, it was possible to sell the idea that if we shut down some golf course pumps, the unpumped groundwater would accumulate down below. And it was also possible for them to swallow the fiction that the water table under Sun City would not drop over the years in concert with that of the communities of Peoria, El Mirage and Surprise.

Further, in my opinion, the idea that the water had to be put to use directly under Sun City "or the public would not accept CAP water" was also used frequently enough by certain Task Force members in casual conversation that people inside and outside the Task Force began to believe it.

Last, without realizing the flaws in their logic, the golf course promoters themselves may have believed a shutdown of the golf course pumps would actually "save" the water presently under Sun City

Re PAGE 7, fourth statement. Beginning with "For example..."

Same childish thinking as above. Please remember the old saying: "An incoming tide raises all ships". The AGUA FRIA RECHARGE PROJECT that HOA belittles can be looked at in the same light as the tide. By participating in the Agua Fria project (which has been designed by professionals and will be managed by CENTRAL ARIZONA WATER CONSERVATION DISTRICT), Sun City residents can avoid paying the \$15,000,000 capital costs of the golf course watering scheme, demonstrate to ourselves and others that we indeed are interested in

preserving the groundwater in an intelligent manner, and yet receive the benefit of being able to recover their CAP allocation at a later date if necessary (a win-win situation if I ever saw one).

For the purpose of delaying subsidence, each molecule of recharged CAP water does not have to move to Sun City in order to be of benefit. Figuratively speaking, the first recharged molecule will displace the next one in the aquifer (so to speak) and the one after that will displace..... etc..etc. And so the recharging proceeds (see "...incoming ....ships" above).

Task Force records pertaining to the CAP use and the evaluation process, reveal the recharge option was by no means "unacceptable". Said evaluation process developed dimensionless numbers that represented the perceived "worth" of each option. The golf course project was deemed to have only 12 % greater "worth" than the recharge project in spite of the apparent bias in the voting. (see attached bar graphs pertaining to "worth"). But to attain that small 12% increase in "worth", the cost would increase 237%!

Did I imply bias in the evaluations? Consider the following:

About halfway through the three-month-long Task Force meetings, one member announced he/she would vote for CAP water use only if it was used on the golf course.

During the critique about the voting process used to establish the "weights" of the various criteria, one member said he/she was weighing the criteria based on his/her "favorite options".

During the actual option evaluation process, the facilitator interrupted the proceedings to proclaim that one person was giving a dramatically higher value to one increment of the options than the rest of the participants. In response to this, that person blurted out, "BUT I WANT MY PROJECT TO WIN"!

At a Task Force meeting prior to the "voting meeting", we were told to weight the relative importance of criteria within a range of one to three. We were also to rate each option on a scale of 1 to 9 as to how well each option meets the criteria. All of this to be displayed in a matrix format. At the close of that (prior) meeting I mentioned to my colleague from HOA that I was going home and prepare my evaluation matrix of the options. He said that was not necessary because "we (implying himself and others, because I certainly had not collaborated with him) have already done that". He then handed me a piece of paper (a copy is attached). I said I would do my own evaluation, copy also attached. Please note the "analysis" by my

colleague from HOA was not an analysis at all under the ground rules because:

1. It did not establish a weight to the criteria.
2. It did not rate each option on a scale of 1 to 9.
3. There no "yardstick" to substantiate his "yes/no" entries.

I still have the copy he gave me. The initials at the bottom are: GZ. It's dated 4/27/98.

In contrast to the biased approach apparently taken by my colleague, I developed a matrix as intended by the facilitator. I've attached my matrix. It's not a copy of the original because the original was scribbled on lined notebook paper and seemed too tacky to include in a package to the Commission. Incidentally, now that I am more familiar with the Agua Fria project because I have read their voluminous proposal, would rate it even higher than I did three years ago.

Now that the Task Force has selected it's preferred option, take a look at a BENEFIT-COST evaluation of that selection (the WORTH was computer-generated by the Task force in response to a series of questions to us).

ITEM	COST
Golf course project:	\$5.80 per month
CAWCD recharge project:	\$1.72 per month
COST difference:	+ \$4.08 per month

ITEM	WORTH (dimensionless number)
Golf course project:	5489.14
CAWCD recharge project:	4920.95
"WORTH" difference:	+ 568.95

% increase in "WORTH":  $568.95/4920.19 = .1156$  say 12%  
(more than the recharge project)

% increase in "COST":  $4.80/1.72 = 2.37$  say 237%  
(more than the recharge project)

Using the data published in the records, the "COST" of the upgrade is nearly 20 times the perceived "WORTH" of the upgrade!!! Is this a bad deal or what?

Re PAGE 8, second statement:

This is a gross exaggeration. There was no "great deal of study" about the concept of using CAP water on golf courses. As I recall, once, some people from Scottsdale came here and described their use of CAP water on golf courses. And Brown and Caldwell did spend time developing the construction costs for the several options under consideration. Of course there the usual observations about the efficacy of

this idea. But there CERTAINLY WAS NO "STUDY" in the engineering sense to validate the stated purpose of the golf course plan which was: "Save the water under Sun City for future use and also forestall the subsidence coming our way." Nor was there any technical evidence given to show why the "saved" water under Sun City would not flow east or west.... only "we know it won't" from proponents.

Re page 8, third statement:

This is not true. The golf course option only looks good at first glance. That is, until the logic that the "saved" groundwater under Sun City will accumulate there is seriously challenged. After all, on this planet, water seeks its own level.

Now, as you look at some quotes from experts on groundwater, how is it possible to conclude that unpumped groundwater under Sun City will remain there if the water table under Peoria, El Mirage and Surprise continues to drop? Remember, we share the same aquifer.

"Groundwater moves in response to differences in hydraulic head between two locations. The direction of movement is always from areas of highest elevation toward areas of lowest hydraulic head." ...David Ozsvath,..."Earth Sciences"

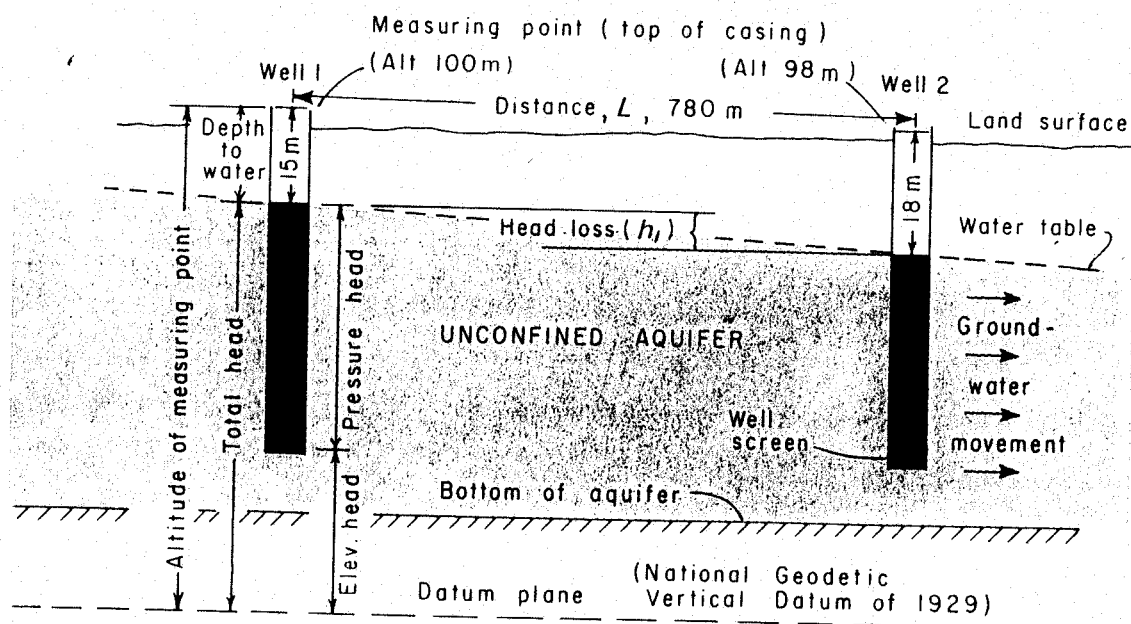
"The direction of groundwater movement is always down the slope of the water table."...C.F. Tolman,...McGraw Hill

"Gravity is the ultimate driving force in groundwater movement. ....The direction of the slope of the water table is also important because it indicates the direction of the groundwater movement." ...U S Geological Survey Water-Supply Paper 2220

"Groundwater will flow from the areas where head is highest, called "recharge areas", to areas where head is lowest, called "discharge areas". ....Because the water table is the upper boundary, contour lines of the water table elevation drawn on a map indicate the direction of flow of ground water in an unconfined aquifer." ...A.E. Kehew, "Geology for Engineers .."

"...the basic principle of groundwater flow holds that water moves from a higher potential toward the lower. The contours on groundwater elevation contour maps are those of equal potential and the direction of movement is at right angles to the contours." ...U.S. Dept. of the Interior, Bureau of Reclamation.

## HEADS AND GRADIENTS



"Water moves from a position of higher hydraulic head to one of lower head, i.e., along a hydraulic gradient which is defined as the difference in hydraulic heads between two points divided by the distance of flow between them."

... Basic Geology for Science and Engineering (I have Xerox copies of several pages but I did not record the publisher).

"The water table is the surface of a water body which is constantly adjusting itself toward equilibrium condition. If there were no recharge to or outflow from the groundwater in a basin, the water table would eventually become horizontal." ... Water Resources Engineering, Mc Graw-Hill.

Re page 8, third statement. Beginning with: "The more..."

HOA has not identified the engineers on the task force who said the golf course project was simple. But whoever they are, it is unlikely that experienced engineers would conclude that a costly project involving miles of buried water piping, million gallon storage tanks, and a powerful new pumping station, etc., would be more simple than another viable option ( the Agua Fria recharge project) which would avoid all construction costs to Sun City.

I consider the third statement to be a piece of fiction.

Please note: By contracting with the Central Arizona Water Conservation District (CAWCD) to place our CAP water into their aquifer recharge area just a few miles north of here, we could receive the benefits of CAP water without any capital costs at all!

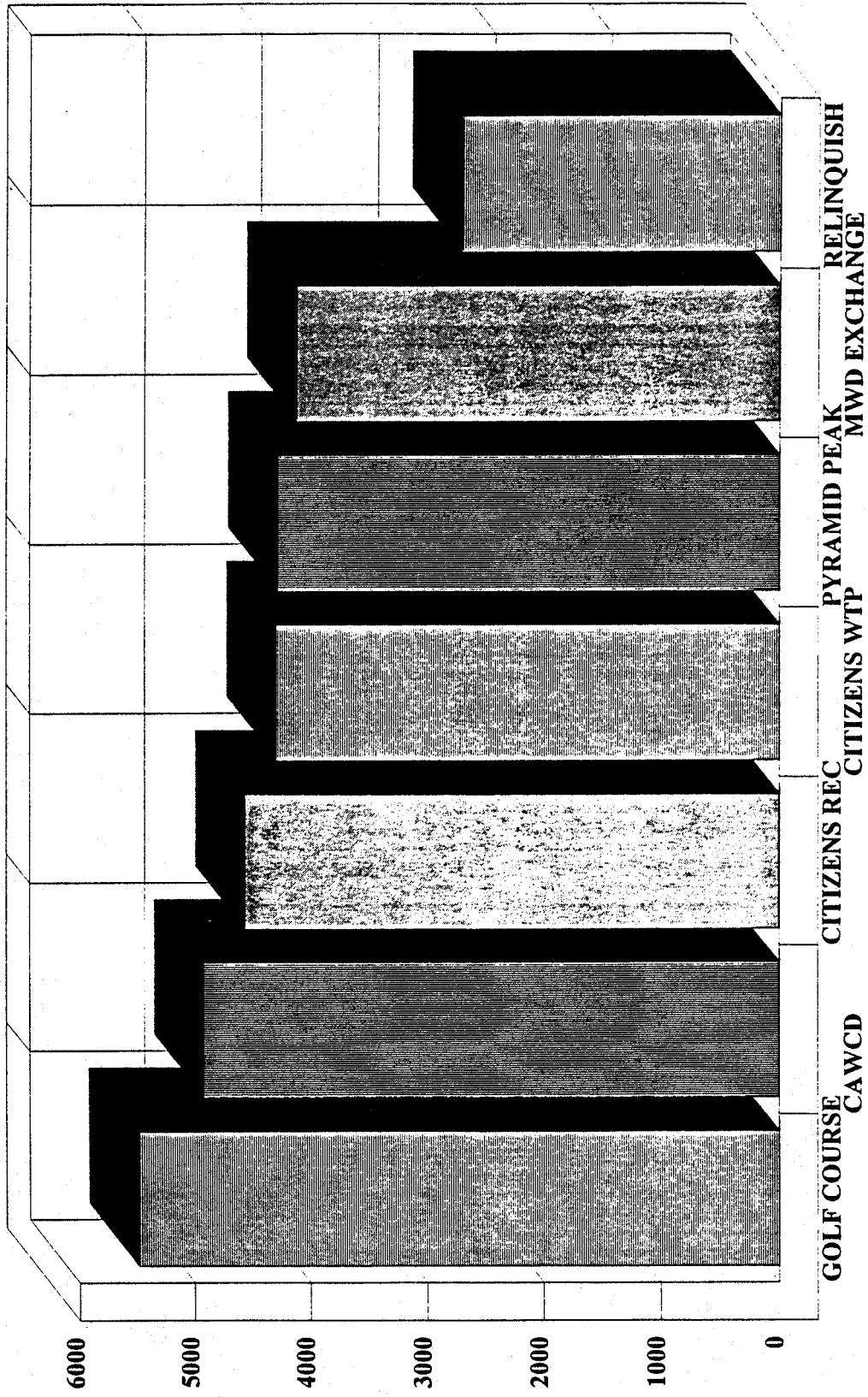
Re page 8, fourth statement, second sentence, beginning with "However..."

Because the Task Force majority did not understand groundwater movement, they were unable to realize that any plan would be irrational if it claimed groundwater presently under Sun City would be "saved" if some golf course pumps were shut down. Of course such a thing will not happen. As the water level under our neighboring communities recedes, the "saved" water will tend to obey the laws of physics and flow "down hill". HOA is congratulating themselves for making an unfounded assumption.

Re page 8, last statement:

There appears to be nothing in the CAP Task Force Report that would convince "the serious student of water use planning" that existing groundwater levels under Sun City would not recede over time in concert with that our neighboring communities. This is probably the most egregious statement in this CAP WATER BOOK.

## Evaluation Results - Worth



*Task Force - w/ Sun City Courts*

OPTIONS →	ENTRIES		RECHARGE		CITIZENS RECHARGE		DIRECT GROUND WATER IRRIGATION		CITIZENS WATER TREATMENT PLANT		LEASE SPACE IN GLENDALE WATER TREATMENT		DIRECT EXCHANGE MARICOPA WATER DISTRICT	
CRITERIA RATED ① TO ③ BASED ON IMPORTANCE (RANGE 1 TO 3) ↓	HOW WELL OPTION MEETS CRITERIA	PRODUCT OF WEIGHT AND EFFICACY	HOW WELL ETC	PRODUCT	HOW WELL ETC	PRODUCT	HOW WELL ETC	PRODUCT	HOW WELL ETC	PRODUCT	HOW WELL ETC	PRODUCT	HOW WELL ETC	PRODUCT
DIRECT BENEFIT TO CUSTOMERS AND MITIGATES DEPLETION ②	THIS COLUMN	THIS COLUMN	⑦	14	⑦	14	⑨	18	⑨	18	⑨	18	⑤	6
EXTENT DEEMED "USED AND USEFUL" ③			⑦	21	⑦	21	⑨	27	⑨	27	⑨	27	⑤	9
TIMELINESS; NOT LATER THAN DEC 30 2000 ③			⑨	27	⑦	21	③	9	①	3	⑤	15	⑨	27
REGULATORY COMPLIANCE. ADWR SAFE YIELD GUIDE LINES ③			⑨	27	⑨	27	⑨	27	⑦	21	⑦	21	⑤	15
PUBLIC ACCEPTABILITY LIKELY PUBLIC CONCURS/ SUPPORTS PLAN ②			⑤	10	⑥	12	⑦	14	⑤	10	⑤	10	③	6
WATER QUALITY. DOES BLEND DEGRADE DRINKING WATER? ①			⑨	9	⑨	9	⑨	9	⑧	8	⑦	7	⑨	9
SUBSIDENCE, MITIGATES POTENTIAL FOR SUBSIDENCE ①			⑤	5	⑤	5	⑤	5	⑥	5	⑥	5	⑤	5
COST (GRADING INVERSELY PROPORTIONAL TO COST ②			⑨	18	⑤	10	③	6	②	4	②	4	⑨	18
→ TOTAL OF PRODUCTS (WORTH)				131		119		115		96		90		95

GENERAL CRITERIA FOR RATING  
CENTRAL ARIZONA PROJECT  
WATER OPTIONS

*Not part of criteria* →

	LEASE FROM CENTRAL AZ WATER CON- SERVATION DISTRICT	CITIZEN'S UTILITIES RECHARGE	DIRECT USE ON GOLF COURSE	CITIZEN'S UTILITIES WATER TREATMENT PLANT	MARICOPA WATER DISTRICT
CONTINUE PUMPING GROUND WATER	YES	YES	NO	NO	YES
DIRECT BENEFIT TO SUN CITY	NO	NO	YES	YES	NO
USE & USEFUL TO SUN CITY	NO	NO	YES	YES	NO
TIMELINESS OR IMPLEMENTATION	SEP 1999	DEC 2000	JULY 2002	DEC 2003	DEC 1998
MEET REGULATORY COMPLIANCE	YES	YES	YES	YES	YES
QUALITY OF WATER FOR SUN CITY	N/A	N/A	GOOD	DRINKING	N/A
SUBSIDENCE IN SUN CITY (PREVENT)	NOT SURE	MAY HELP	HELP PREVENT	HELP PREVENT	NOT SURE
EST. MONTHLY COST (1)	.24/MO	2.69/MO	4.32/MO	5.67/MO	-.20/MO
PER HOUSEHOLD (2)	.24 MO	2.94/MO	4.65/MO	6.58/MO	-.20/MO
(CAPITAL/OPERATING)					
(1) COMBINED WITH SUN CITY WEST					
(2) SUN CITY ONLY					
NOTE: ESTIMATED ADDITIONAL MONTHLY COSTS FOR HOLDING CAP WATER AND DELIVERY CHARGE	1.48	1.48	1.48	1.48	1.48

## **AGUA FRIA RIVER RECHARGE PROJECT**

The Agua Fria Recharge Project (project) is being developed by Central Arizona Water Conservation District (CAWCD) as a State Demonstration Recharge Project constructed for the benefit of the State of Arizona and funded by property tax revenues collected by CAWCD in its capacity as a tax-levying public improvement district of the State. The primary purposes of this recharge project are to replenish the severely over drafted aquifer in the West Salt River Valley and create an opportunity to more fully use Arizona's unused Colorado River allocation.

The project will utilize the natural channel of the Agua Fria River and constructed spreading basins to recharge up to 100,000 acre-feet per year of Central Arizona Project (CAP) water and replenish the aquifer in the west Salt River Valley. The project area extends from the CAP Aqueduct-Agua Fria River Siphon, downstream within the Agua Fria River channel for approximately 4.5 miles to a series of infiltration basins to be located north of Hatfield Road and west of 107th Avenue. The project area includes portions of Sections 17, 20, 29, 31 and 32, Township 5N, Range 1E, and Section 6, Township 4N, Range 1E. CAP water will be discharged from the siphon and flow downstream within the natural channel to a small earthen diversion dam located near Jomax Road. From this point the water will be conveyed to the recharge basins.

As a State Demonstration Project, authorized by statute, the project will benefit the state in the following ways: 1) protect the general economy and welfare of the state and its citizens by encouraging the use of renewable water supplies instead of continued reliance on limited groundwater supplies; 2) store currently unused CAP water for future needs through recharge and replenishment of over drafted aquifers; and 3) provide an additional source of water for times of serious water shortage due to a substantial reduction in the supply or a prolonged interruption of deliveries of CAP water.

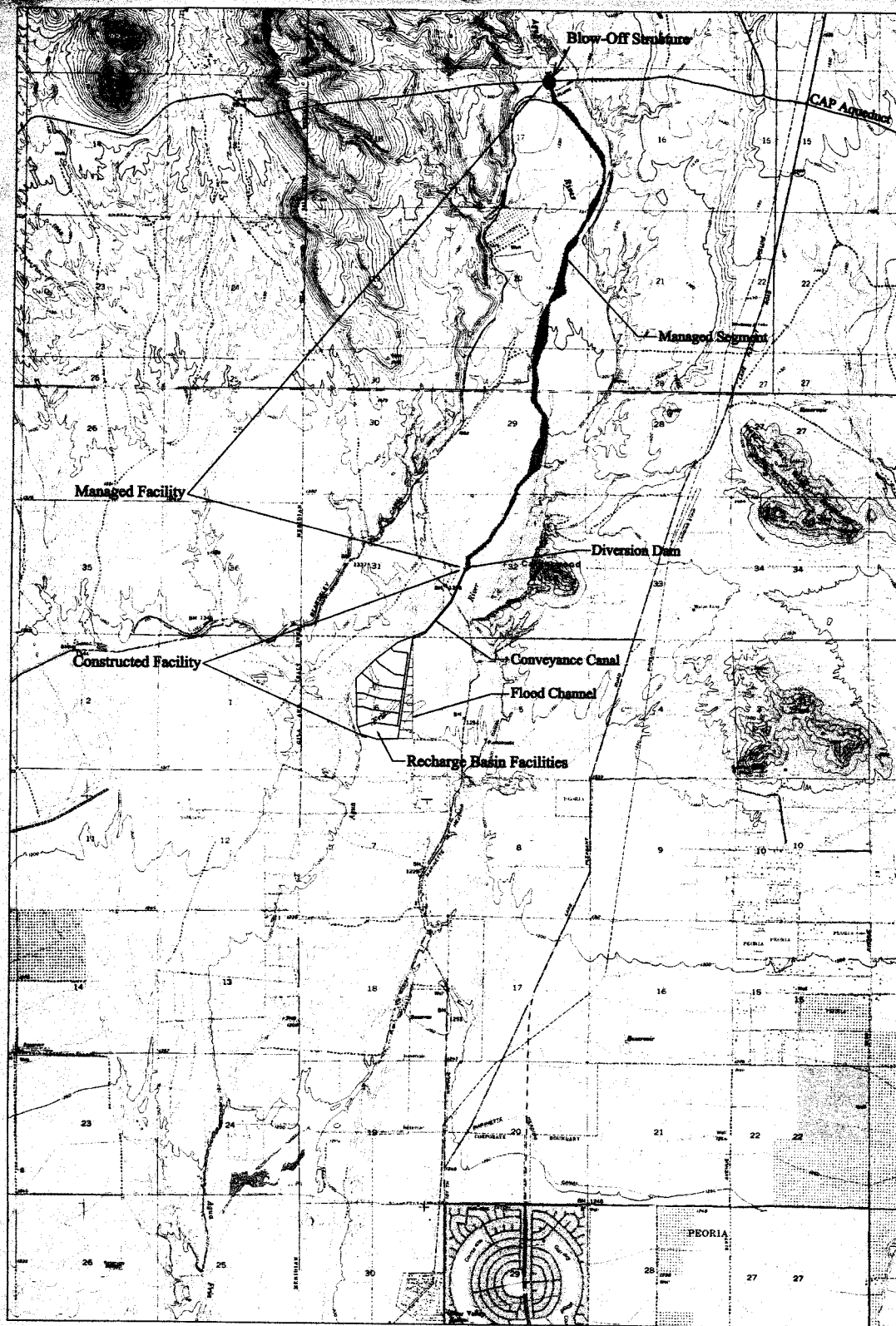
Benefits resulting from recharge will be most notable within the West Salt River Valley that includes portions of Phoenix, Glendale, Peoria, Sun City, El Mirage, Youngtown and Surprise. Decades of groundwater pumping for agricultural irrigation in this area has resulted in lowering of groundwater levels by over 350 feet directly south of the project area and this trend is projected to continue. Groundwater overdraft in the West Salt River Valley has resulted in increased energy costs to pump groundwater from greater depths, deterioration of water quality by withdrawing poorer quality water from deeper in the aquifer and geologic hazards such as land subsidence, earth fissuring and aquifer compaction.

The project is located at the margin of an area where groundwater declines have been most severe and where recharge will directly replenish aquifer water levels and mitigate the negative impacts of overdraft. The Arizona Department of Water Resources (ADWR) supports this project for its hydrologic benefits and has issued the necessary permits to authorize construction.

A number of state and municipal entities are dependent on recharging CAP water in this project to achieve their respective mandates. The Arizona Water Banking Authority (AWBA) was created by the legislature in 1996 to recharge CAP water in order to firm existing water supplies for municipal and industrial users for future shortages; to help ADWR meet the water management objectives required by state law; and to assist in the settlement of Indian water rights claims. Unfortunately, the lack of available recharge facilities currently limits the AWBA ability to achieve its goal of recharging 500,000 acre-feet annually. The AWBA strongly supports the project and has committed to storing at the project because: 1) AWBA is required by statute to utilize state demonstration recharge projects; 2) the 100,000 acre-feet of storage capacity will bring the AWBA much closer to realizing its annual goal and 3) recharge at the project will achieve significant water management benefits by replenishment of the West Salt River Valley's over drafted aquifer.

The Central Arizona Groundwater Replenishment District (CAGRDR) will use the project to help fulfill its groundwater replenishment obligation for the Phoenix Active Management Area. The CAGRDR must replenish the aquifer to replace excess groundwater pumped by municipal providers. Recharge at the project will allow the CAGRDR to achieve maximum water management benefits by allowing it to replace groundwater pumped by West Salt River Valley municipal water providers through recharge in the same geographic region that is was withdrawn. Without the project, the CAGRDR will have to settle for recharge at projects in less desirable locations that may not directly replenish the effected aquifer.

West Valley cities that elect to recharge all or a portion of their CAP allocations at the project will receive significant economic benefits. CAP water stored underground at the project can legally be recovered by municipalities using existing service area wells, even if located far from the recharge project, thereby eliminating the need to construct expensive water treatment plants and pipeline distribution systems in order to take delivery and use of their CAP allocations. Cities that recharge and recover CAP water will also benefit by reducing their dependence on limited groundwater reserves by taking advantage of currently available excess CAP water at subsidized water rates.



0 1/2 1  
Distance in Miles

N

R1W/R1E

Explanation



Managed Segment

**HydroSystems, Inc.**  
GARY G. SMALL, M.S., P.G., C.E.I.  
1230 S. PARK LANE, SUITE 5, TEMPE, AZ 85281  
TELEPHONE: 602-517-9050 FAX: 602-517-9050

# Project Location Map Agua Fria Recharge Project

Figure 1